REMARKS

Allowable Subject Matter

No claim was indicated as having allowable subject matter.. The Office Action was non-final. A Request for Continued Examination was accepted and the finality of the previous Office Action was withdrawn.

Rejections Maintained

1. Rejection of Claims 6-8 and 10 under 35 USC 103(a)

Claims 6-8 and 10 were rejected under 35 USC 103(a) as being unpatentable over US 5,079,600 (Schnur et al.) in view of ASM Handbook Vol. 5, Surface Engineering, ASM International: Materials Park, Ohio, 1994, pp. 315-318, and the basic textbook by Porterfield, Inorganic Chemistry, A Unified Approach, Addison-Wesley: Reading, Massachusetts, 1984, pp. 487-488.

Regarding claim 6, Schnur et al. is said to disclose:
(a) a substrate;
(b) a diffusion barrier comprising a self-assembled monolayer (SAM), each molecule having an aromatic group at the terminus of the molecule;
(c) a metal layer.

It was said to be inherent that the SAM of Schnur et al. is a diffusion barrier because Schnur et al. states that the diffusion of copper into the thermal oxide does not occur, citing Example 24. The burden was placed on Applicants to show that the structure of Schnur et al. does not possess the characteristics relied on.

It was acknowledged that Schnur et al. does not each that the catalyst is copper and **does not have the limitation that "for each molecule of the plurality of molecules, the copper in the metal layer is in direct contact with the aromatic group of the molecule."**

This is because **Schnur et al. does not disclose a diffusion barrier**. The self-assembled monolayer is used for purposes of patterning a subsequently applied metal in a metal bath. Use of a metal bath requires the use of a Pd/Sn catalyst (See Col. 9, ll. 10-16).

The ASM Handbook was cited as teaching that "copper may be used as a catalyst for electroless plating of copper (pp. 315-318...)." The basic textbook of Porterfield was cited as showing "that copper forms metal complexes with pyridine groups, such as the pyridine group used in Schnur et al. as the polar end group of each molecule in the SAM barrier layer."

The Office Action further stated (page 5, para. 4) that it would be obvious to use copper as the metal catalyst in Schnur et al. Schnur et al. was said not to be limited to Pd/Sn catalysts, it therefore allegedly being obvious to switch Cu for the more expensive Pd/Sn catalysts.

With regard to the Declaration submitted by co-inventor Ramanath, the Office Action states that Schnur et al. discloses the **exact same** "**SAM molecules** having aromatic end groups, such as trichloro(4-pryyidyl)-ethyl-silane (Schnur et al., Col. 21, 'EXAMPLE 28') – which is the exact same SAM molecule as used in the instant application."

Response

Claims 6-8 now require that the diffusion barrier comprise molecules that contain an aromatic group and a trialkyl oxy group. Claim 10 has been cancelled.

With regard to the limitation that the "copper in the metal layer is in direct contact with the aromatic group of the molecule," Applicants agree with the Examiner that Schnur et al. does not teach this. However, **the present claims do not recite the use of a catalyst at all. It cannot therefore be obvious to substitute one catalyst for another.** The copper that is referred to in claim 6 is recited as a "metal layer comprising copper." As described in the specification, copper is becoming the metal of choice for forming conductive patterns

in integrated circuits; however, it is desirable to have a diffusion barrier to prevent its diffusion into the substrate. This is the diffusion barrier referred to in step (b) of claim 6. There is a catalyst in Schnur et al., but no diffusion barrier. Schnur et al. applies a silane layer, then patterns it by irradiation, with the purpose of later applying a metal conductive layer that will only adhere to unirradiated portions of the silane. The catalyst is needed to cause the metal to adhere to the silane. The palladium/tin catalyst used by Schnur et al. is not the metal conductive layer in that device. **Therefore, substituting copper for the palladium/tin catalyst would not recite in the claimed structure, because the palladium/tin catalyst is not a "metal layer" as recited in claim 6.** As shown in Fig. 3A, the catalyst does not, and is not intended to, form a layer.

With regard to the assertion that Schnur et al. must inherently anticipate the claimed structure because the "exact same molecules" are used, claim 6 has been amended to recite that the molecules of the diffusion barrier contain a trimethoxy silane group. **The use of a trimethoxy group is not taught or suggested by Schnur et al.**.

Example 1 of Schnur et al. discloses the use of UTF1, 7-octenyldimethylchlorosilane. Example 9 uses UTF3, 4-aminobutyldimethylmethoxysilane. There is only a single methoxy group in this molecule. Example 22 uses UTF4, 1,1,1,3,3,3-hexamethyldisilazane. Example 28 uses trichloro(4-pyridyl)-ethyk-silane. Additional materials are disclosed in Example 24. None of these are trimethoxy. Trimethoxy is not obvious from Schnur et al. because there is no teaching to suggest optimization in this direction. The recited trimethoxy group is less reactive with the silicon substrate than the materials used by Schnur et al. It therefore does not affect the switching properties by entering into the silicon. This is important in a thin layer application, whereas, in Schnur et al., the SAM layer is subjected to further processing. The chlorine atoms in the films of Schnur et al. would increase leakage if used as diffusion barriers, as recited in claim 6.

The importance of the chemistry is illustrated in Fig. 3 of the present specification, wherein small chemical differences affect barrier time to failure.

2. Rejection of Claims 9, 11 and 13-18 under 35 USC 103(a)

Claims 9, 11 and 13-16 were rejected under 35 USC 103(a) over the combination above[1] further in view of Wolf et al. Silicon Processing For the VLSI Era, Vol. 1-Process Technology, 2nd Ed. Pp. 438, 782-783 (2000). This was cited to show that copper interconnects may be deposited by a variety of methods "such as PVD (e.g. sputtering) and CVD…."

Regarding claims 13 and 17, Schnur et al. is said to be capable of the $j_{leakage}$ properties recited.

Wolf is said to teach that the copper interconnect fills a hole, such as is recited in claim 11.

Response

Claim 9 depends from amended claim 6, discussed above.

Claim 11 depends from amended claim 6, discussed above.

Claim 13 has been amended to recite that the molecules of the diffusion barrier contain a trimethoxy silane group, as discussed above.

Claim 15 has been amended to recite that the linear molecule has two carbon atoms. This corresponds to SAM1 shown in Fig. 3 as having the highest time to failure.

Conclusion

It is believed that the present Amendments place the application in condition for

[1] US 5,079,600 (Schnur et al.) in view of ASM Handbook Vol. 5, Surface Engineering, ASM International: Materials Park, Ohio, 1994, pp. 315-318, and the basic textbook by Porterfield, Inorganic Chemistry, A Unified Approach, Addison-Wesley: Reading, Massachussetts, 1984, pp. 487-488 and , and the basic textbook by Porterfield, Inorganic Chemistry, A Unified Approach, Addison-Wesley: Reading, Massachussetts, 1984, pp. 487-488.

allowance. Allowance of claims 6-9, 11, and 13-18 is respectfully requested. Such action, as well as the timely issuance of a Notice of Allowance is earnestly solicited. If a telephone conference would be useful in this case, the Examiner is encouraged to call the undersigned at the number below to discuss any prosecution issues.

Respectfully submitted,

PETERS, VERNY, JONES & SCHMITT, LLP

By ________________

David J. Aston, Reg. No. 28,051
Tel.: (650) 324-1677
Fax: (650) 324-1678